

CHICAGO
AIRPORT
CONFERENCE

DECEMBER 12-15 1927
HOTEL SHERMAN, CHICAGO

*Every New Avenue of Transportation
Brings Added Prosperity*

—WM. HALE THOMPSON, Mayor

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Proclamation

December 9, 1927.

Whereas, a National Airport Conference has been called to be held in this city on December 12, 13 and 14, 1927, and invitations have been sent to the mayors of cities throughout the United States requesting that they and all public-spirited citizens within their respective cities interested in promoting the standardization of airports and the illumination of airports and landing fields attend such conference; and

Whereas, it is fitting and proper that the first conference of this character be held in the City of Chicago, which city is destined to become the center of aero activities in the United States;

Therefore, I, William Hale Thompson, Mayor of the City of Chicago, do hereby proclaim the week commencing Sunday, December 11, 1927, as AVIATION WEEK, and I request all our citizens to extend every courtesy to the visiting delegates in attendance, and I further request that aviation merchandise be displayed as prominently as possible by the stores and other business houses within our city having the same.

(Signed) WILLIAM HALE THOMPSON,
Mayor.

CHICAGO AIRPORT CONFERENCE

THE MAYOR OF THE CITY OF CHICAGO has called this conference in an effort to promote commercial aeronautics in the City of Chicago and in the nation, thus indirectly assisting in the program for National Defense. It is hoped that as a result, progress may be made toward promoting greater aerial activity not only in Chicago, but in and between other cities. The Mayor believes that in assisting in the development of this new means of transportation, a closer contact will have been established between Chicago and all other cities of the country. There will result that new impetus to business always given by an improved means of transportation and communication.

Much of the data presented here relative to the construction and standardization of airports has been secured from, and reprinted herein with the permission of, the Bureau of Aeronautics, Department of Commerce. Details relative to the program and activity during the week have been under the supervision of the Chicago Aero Commission.



THE CITY OF CHICAGO has established at 63d Street and Cicero Avenue a new municipal airport which, when completed, will be second to none in the country. Its total area will be approximately 300 acres. One-half of it has already been improved and during the next year the remaining portion will be completed.

The airport is now in use by the various air transport companies carrying air mail, passengers and express. No less than six regularly operated routes now center at Chicago over which planes fly daily from the Atlantic to the Pacific, and from the Lakes to the Gulf.

The airport is completely lighted for night flying activity and is served by the Federal Weather Bureau Service, established by the United States Department of Commerce. The lighting consists of a complete boundary light system, beacon lights and large floodlights. In addition, the airport is the center of operation for a number of aviation schools and local passenger, taxi, and aerial photographic services.

On the following pages will be found a map showing the location of the airport in relation to the city, a large scale drawing of the airport itself, as well as a list of the flying facilities, aids to navigation, etc., already provided.

Actual construction work on the airport has been carried forward by the Public Works Department of the city, under Commissioner Richard W. Wolfe and Walter Wright, Superintendent of the Bureau of Parks. The Chicago Aero Commission has functioned in planning the improvement work, and seeing to it that the same was carried to completion. The personnel of this commission is as follows:

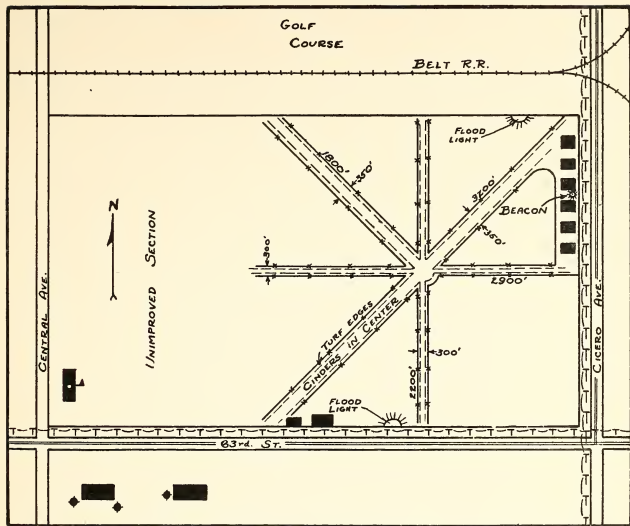
COLONEL PAUL HENDERSON— *Chairman*

MR. JAMES SIMPSON
MR. GEORGE B. FOSTER
MR. EDWARD STEDMAN
MR. M. L. BROMBERG
ALDERMAN DORSEY R. CROWE

MAJOR REED LANDIS
MAJOR R. W. SCHROEDER
MR. JOHN M. GLENN
MR. M. C. MEIGS
MR. EDWARD J. KELLY

CAPT. J. W. DISETTE
ALDERMAN JOSEPH B.
McDONOUGH
ALDERMAN ALBERT J. HORAN
MAJOR PHILIP G. KEMP

CHICAGO MUNICIPAL AIRPORT



Description and Facilities

POSITION

Lat. $41^{\circ} 48'$; long. $87^{\circ} 45'$; alt. above sea level, 593'; mag. var., $1^{\circ} 53' 45''$ E., 1927; annual decrease, $3' 36''$.

Distance and direction from city, 9 miles W. of Lake Michigan and Jackson Park. See map.

DESCRIPTION

Size, 5,280' x 2,640'; acres, 300; shape, oblong.

Surface, sod; gradient, level; drainage, tile.

Landing strips or runways; four—N./S., 2,200' x 100'; E./W., 2,900' x 100'; NE./SW., 3,200' x 150'; NW./SE., 1,800' x 150'.

Marking thereof, black cinders with white edgings.

OBSTRUCTIONS

Circle on hangar roof in NE. cor. Trolley wires on E. and S. sides of field; beacon tower and buildings at E. side; school building with 125' stack in SW. corner; small building at S. end NE./SW. runway.

LIGHTING

Beacon, 24" rotating, 6 r.p.m., 4,500,000 c.p., at E. center. Beacon, 36" revolving. Boundary lights along runways.

Floodlights for landing—2 large

B.B.T.

Illuminated wind cones.

Red lights on pole lines at E. and S. sides of field and all other obstructions.

ACCOMMODATIONS

Personnel for servicing and repair, yes.

Hangars, seven two, 142' x 80' x 16' clearance; two, 145' x 70' x 16' clearance; one, 125' x 80' x 18' clearance; one, 100' x 70' x 14' clearance; one, 100' x 80' x 18' clearance.

Specification fuel and oil, yes; guard, yes.

Fire apparatus, hand extinguishers and city fire department.

Quarters, none; meals, nearby.

Transportation to city, street car.

COMMUNICATION

Telephone, yes; telegraph, phone. Radio, by phone.

Radio dispatch—East and West.

METEOROLOGICAL DATA

Prevailing winds, summer, NE.; winter, SW. to NW.; annual, SW. and NE.

Heaviest winds are usually from SW. or NE., except in winter, when strong NW. winds are re-

corded. Winds of 40 m.p.h. or over are recorded 2 d.p.m. in summer, 3 during autumn and winter, and 5 in spring. Highest recorded velocity, 84 m.p.h.

Dense fog occurs about 1 day in six weeks. Light fog averages 2 d.p.m. in summer and 3 d.p.m. during the other seasons. Fogs are most prevalent between midnight and 10 a. m. During the winter months fogs frequently occur in the late afternoon or evening.

Precipitation as heavy as 1" or more in 24 hours is recorded about 1 day in 2 months, with greatest frequency during the months Dec. to Mar., inclusive. Average snowfall, Dec. to Mar., is about 8".

Weather map; display board, yes. Nearest Weather Bureau, service at field by phone.

Nearest upper-air observer service at field by phone.

REMARKS

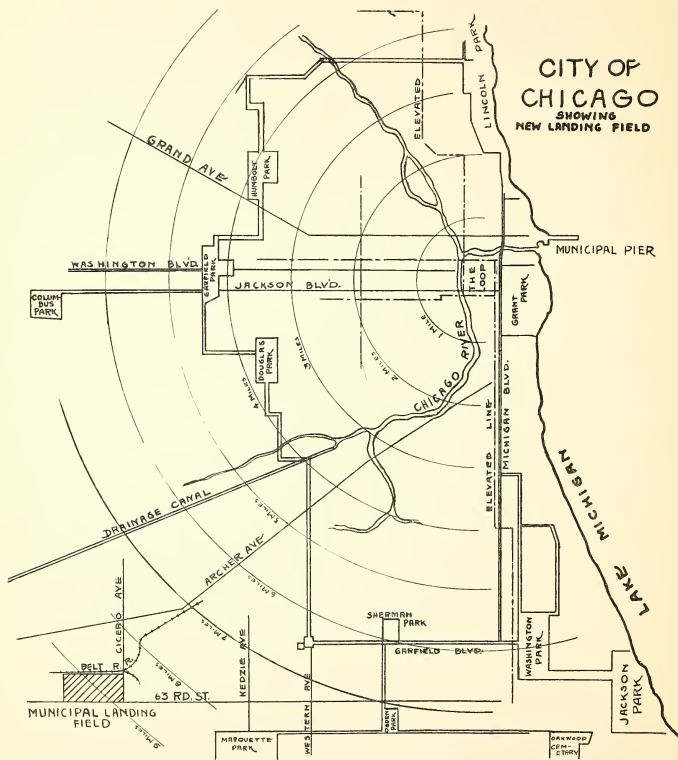
Pilots are cautioned to stay on cinder runways, as turf is soft in spots.

AIRPORT MANAGER

J. A. Casey. Office on Field.

CITY OF CHICAGO

SHOWING
NEW LANDING FIELD



CONSTRUCTION OF AIRPORTS

Definitions

1. *Airport*.—The term means any locality, either of water or land, which is adapted for the landing and taking-off of aircraft, and which provides facilities for shelter, supply and repair of aircraft; or a place used regularly for receiving or discharging passengers or cargo by air.

2. *Landing Strips*.—A landing strip is an area which forms part of an airport and which is suitable for the landing and taking-off of airplanes. This suitability may be due to an unusually heavy turf or other natural condition, or it may be due to special construction by use of gravel, cinders, slag, or other material.

3. *Runways*.—In the case of artificial preparation a landing strip is called a runway. The difference to be emphasized between the two is that a landing strip need not be of artificial construction if the ground

is suitable for the landing and taking-off of airplanes under average weather conditions. The runway is specially constructed for the operation of airplanes on ground which would otherwise not be suitable for landing and taking-off.

4. *Two-way, three-way, four-way fields*.—Airports and landing fields are styled two-way, three-way, four-way, six-way, etc., according to the number of directions in which airplanes may land and take off. A rectangular field which permits landing along its longest dimension only is a two-way field, as it may be approached from only two directions. A square field crossed diagonally by two runways provides four-way landing. A triangular field having runways parallel with its sides is a six-way field. The best condition is that realized when a field is available for landing in all directions. Such an airport is called "all-way."

AIRPORTS

Need for Airports

The necessity for well designed airports has become apparent with the rapid growth of civil aeronautics. With the increase of air traffic, cities without airports are finding themselves in the same class as coastal cities without well equipped, sheltered harbors. Naturally those cities which possess good airports will attract present and future air commerce. The existence of such airports and the favorable public attitude indicated by such possession will cause cities to be carefully considered as stopping points on the official civil airways of the United States.

The commercial value of an airport is not its only consideration. It has an important value as a recreation facility similar to city parks, golf courses, equestrian trails, bathing beaches, etc., and it should be a municipal enterprise. The Air Commerce Act of 1926 recognizes this by providing that civil airports should not be owned or operated by the Federal government.

In general, the airport should be large enough for absolute safety of operation, easy of approach from all directions and quickly reached from the city. It should be planned to care for future rapid increases in aeronautics. At first the municipal hangars may be available for housing public planes and public transport craft. Later, when traffic becomes too heavy, the

municipal airport may become a place for the mere taking on and discharging of passengers, mail, express and freight. It will be to the airway what the railroad terminal is to the railways. After unloading, the transport planes will be flown to larger fields on the outskirts of the city where they will be serviced and held until ready for return trips.

Another benefit from the construction of airports is the increase of public confidence in air travel. The people of the United States will soon become accustomed to this new method of transportation when it is placed continually before their eyes.

Each airport will have to be constructed under conditions peculiar to its own locality. This bulletin will not serve as a close guide, but rather as a compilation of suggestions from which each city may work out its construction problems.

Selecting the Site

Basic Requirements.—The field should be firm, approximately level, well-drained, without obstructions or depressions presenting hazards in taking-off and alighting, and with clear and safe approaches. One location may appear to be larger than another yet still offer less space for landing strips.

By "hazard" is meant any obstacle, object or condition that renders operation dangerous under any expected conditions.

If no site can be found to fulfill the higher requirements, then the field should permit the laying out of at least two landing strips 150 or more feet wide, the angle of crossing or converging not less than 45 degrees. These landing strips, whether runways or natural surfaces, must permit safe landing under ordinary weather conditions. This includes average rainfall and snowfall.

The field should permit margins of at least 100 feet between the outer edges of the landing strips and the boundaries of the field.

The site should be situated on a good highway leading to the nearest city or town, or capable of immediate connection thereto.

3. *Prevailing wind.*—The direction of the prevailing wind is always important, as airplanes in most cases land directly into the wind. Crosswind landings can be made by expert pilots, but this practice is not recommended, especially in aircraft used for public transportation. When the airport is not available for landing in all directions, the longest landing strip should, when possible, be aligned with the direction of the prevailing wind. If not possible, the nearest approach to this condition should be made. (See Figures 1 and 2.)

4. *Wires.*—In addition to being obstacles, as mentioned preceding, telephone, light or power wires carried on poles at the edge of a field constitute continual menaces. Pilots will naturally attempt to glide as close as possible to the wires, which are often difficult to see. The risk of catching the landing gear in such obstacles is always present, and the result of such an accident is usually serious. If the wires happen to carry a high voltage, the danger is increased. Whenever possible all wires along the boundaries of flying fields should be placed underground.

5. *Ditches, ruts, etc.*—Ditches, ruts or deep cut roads are naturally obstructions and must be filled in before the field can be used; however, the presence of small hammocks or depressions in an otherwise good site should not prevail against its use, for they can be levelled or filled as necessary. No road should ever be permitted to cross the landing area of an airport.

6. *Fog.*—One of the greatest hazards in flying is fog. Even expert pilots find great difficulty in flying and operating under such conditions. A field which lies in a section affected by fog should not be chosen unless it is the only one available.

7. *Rivers, marshes, etc.*—The presence of rivers, marshes, etc., along the boundaries of otherwise perfect fields must be carefully considered. The advantage of using a stream for a seaplane anchorage may outweigh the disadvantage of taking off land planes over the water. The size of the field in such a case should eliminate risk of descending into the water in case

of a forced descent. Whenever the size of the field does not give a margin of safety in taking off over marshes, rivers, etc., it should not be used unless absolutely necessary.

8. *Rare air, high altitudes.*—Airports located at high altitudes must be larger than those at sea level, as the rarefied air does not permit operation of airplanes at the same speed. Landings and take-offs must be made at higher speed which necessitates additional space.

9. *Obstacle formula.*—The presence of any obstacle reduces the available landing area by a distance equal to seven times the height of the obstacle. For instance, as shown in Figure 3, the power lines on the edge of the field reduce the area for landing by a rectangle BMNC. The distance BM is 350 feet as the poles are 50 feet high; in other words, the field ABCD must be increased by the rectangle AFED to make it of proper size.

10. *Proximity to city.*—The proximity to the nearest city or town is an important factor. An airport fifteen miles from a city will not be as valuable as one within three or four miles. The air traveller will not care to save two hours by airplane and then lose one-half of it in going from the airport to the city. However, this should not be construed as advising the choice of a nearby site which is otherwise unsuitable.

11. *Transportation to city.*—The city should be connected with the airport by several forms of transportation, such as automobile, electric line, and even a railroad if this will give more efficient connection with the city. In case of an airport located on an island immediately opposite a city there should be a bridge or frequent boat service.

12. *Availability of light, power and water.*—Electric light, power, and water supply are absolutely necessary at airports. A site close to power and water mains will easily solve this problem if the area is otherwise suitable. A well may be sunk if water is not available.

13. *Cost of land.*—The cost of land will naturally be one of the important factors in selecting a site; however, no location should be eliminated because of its apparently high cost when the other advantages and the possibilities for future expansion outweigh the cost price.

14. *Possibilities of expansion.*—It is well to have a large area for a beginning. This may be reduced or used for other purposes if it is later found unnecessary. It will be easy and profitable to reduce such areas, but very difficult and costly to expand small fields unless careful provision has been made for this change.

The matter of expansion should be kept in mind in connection with buildings, depressions, streams, etc. Trees may be cut down, depressions filled, mounds levelled, etc., but real-estate developments, rivers and cliffs will balk efforts at expansion.

15. *Building restrictions.*—In order to make sure that a good airport site will not have its approaches

restricted by the erection of high buildings, it is well to cover this matter with an ordinance or ruling by the zoning commission. The establishment of an airport usually increases the value of adjacent land, and if such a precaution against building is not taken in a short time, the airport may be entirely unsuitable for operation.

If it is possible to use the harder surfaces such as concrete or macadam for part of the runways, this should be done. The harder surfaces would, of course, be placed at the portions most likely to be used for landing and taking off.

The length of runways is covered in the subject of field rating. The minimum width approved by the Department is 100 feet, and if possible runways should be wider than this. Three hundred feet would be an ideal width, but such a large dimension is usually not now warranted from a financial standpoint. The margin between the edge of a runway and the nearest field boundary should be not less than 100 feet, and more, if possible. Obstacles near runways reduce the available area by a distance of seven times the height of the obstacle.

The drainage of runways is an important matter. A thick layer of cinders may be placed over drainage tile. The entire runway in this case should be made flush with the surface of the field so that planes may land and take off across it without difficulty. This necessitates digging down about two feet to place the tile and cinders correctly. If possible, the cinders should be covered with some suitable material to bind them together and avoid throwing particles into propellers. The main drain of the runway would run longitudinally, with short drains to lead off the water at regular intervals.

An alternative suggested by various authorities is the use of gravel mixed with a good clay binder and compactly rolled. In some cases grass may be used to hold the mixture together.

6. Marking of landing strips.—Landing strips or runways should be indicated by arms projecting from the standard circular marker. The method of constructing the arms and the marker is discussed under the heading, "Day Signals and Identification Markings," Sections 1 and 2.

7. Drainage.—If the field is of sand or gravel, or of soil of medium density, it will drain naturally after a rain. This will usually apply to fields surfaced with tough sod. When the natural drainage is not sufficient, artificial drainage must be used, such as ditches filled with sand or coarse gravel, stamped down flush so that planes may roll smoothly. Tile drains are very desirable. Drainage is extremely important and should not be neglected in laying out the landing area.

Drainage by use of cisterns is recommended by some authorities on airport construction. Cisterns are placed in the lowest parts of the landing area with suitable tops over which planes may run without danger. A

concrete slab containing a small grating will fulfill these requirements. The center of the slab should be sunk so that the water will drain down into the cistern and the sides should be rounded to prevent tail skids catching against them. The cisterns can be drained by short lengths of tile. The cistern itself may be constructed of building tile or concrete. In place of the concrete slab and grating previously mentioned, a man-hole cover may be placed at the top of the cistern.

16. Margins between landing strips and boundaries.—Where the entire field is not suitable for operations, landing strips are necessary. The site selected must permit at least 100 feet margins between the landing strips and the edges of the field. An illustration of the margin layout is shown in Figure 4.

17. Clear approaches.—The matter of approaches is closely connected with the foregoing, as stated in the basic requirements. Airplanes should be able to approach easily and safely from all directions. A square field 2500 feet on a side and otherwise fulfilling the requirements, but bordered on all four sides by poles 50 feet high, will have an all-way landing area only a square 1800 feet on a side. This is illustrated in Figure 5, in which the obstacle formula applies.

Layout of the Field

1. Application of rating suggestions.—Before laying out the field, constructors should study the sections on rating and the sketches showing application to various shapes of fields. This will be helpful in figuring the longest possible landing strips when the entire area is not available.

2. General considerations.—Before the actual layout of facilities and equipment, the approved site will presumably have been prepared for operation so far as the surface of the ground is concerned. Roads and ditches will have been filled, hummocks levelled and approaches cleared as much as possible by cutting trees and putting underground light and power lines wherever possible.

3. Surface of the field.—If the natural turf or sod is not quite tough enough for continual landing of airplanes it may be made available by sowing special grass. The kinds of grass used will vary in different parts of the country. Application to the nearest agency of the Department of Agriculture or to the Department of Agriculture at Washington, D. C., will secure expert advice on this subject.

4. Landing strips.—If the entire field is not available for landing, the best area should be selected and used for landing strips. They should be laid out to afford the longest possible run. One strip should be aligned with, or as near as possible with, the prevailing wind. These landing strips are not necessarily runways of cinders, gravel, etc., but may be only a part of the field which has suitably tough sod or turf. Boundaries between landing strips and edges of the field must be at least 100 feet. Obstacles near the

landing strips must be removed by a distance equal to seven times the height of the obstacle. (Fig. 3.)

5. *Runways.*—When the natural surface of the field is not solid enough, runways may be constructed. The best material for runways is concrete, macadam or some similar surface, but such construction is usually beyond the financial resources of the average city. In lieu of these materials, cinders, gravel and slag are often used. The objection to cinder runways is that tail skids of planes usually tear up the surface so that cinders are thrown into the propeller to their damage.

Construction of Buildings and Equipment

1. *Location of buildings.*—Airport buildings should be arranged along the side of the landing area where they interfere least with landing and taking-off. In case of a rectangular field this is easy of application as the buildings can be arranged as shown in the Figure 6. This does not seriously reduce the available landing area as would be the case with the field exactly square. Whenever an adjacent strip of land offers possibilities for hangars, shops, etc., it should be used, rather than cut down the landing space.

There is no recognized form of layout for buildings, as these will vary with each field. The system shown in Figure 6 is recommended by prominent designers.

A section of an irregular shaped field which would be unavailable for landing may be used for location of the necessary buildings, thus removing these obstacles from the portion used for operations. (Figure 7.)

Buildings should be placed most conveniently for connection with water, light and power mains. They should also be well spaced to reduce fire hazard. Provision should be made for a road to most directly connect with the highway, without crossing the landing area.

At larger airports where there is need for a railroad spur or a siding, tracks should be laid along the rear of the buildings. To eliminate unnecessary operation on these tracks the supply buildings should be placed as close as possible to the main line.

All of these considerations should be weighed after the most important factor of clear approaches and largest landing area is settled.

2. *Fuel supply.*—The fuel supply system should be located most conveniently for servicing planes without unnecessary taxing. In small airports it may be placed near the road so that gas and oil may be supplied to automobiles, thus adding to the revenue. In larger airports a fuel truck may be used, though this will not always be warranted. Ordinarily the supply tank should be placed underground and at some distance from the outlets. One method is to have a regular filling station pump connected by piping to a

trap containing a coil of hose. Planes can be taxied to the trap, gassed and moved away under their own power. The trap lid is flush with the field so that it constitutes no obstruction. At smaller fields a filling station pump may be used with only a slightly longer length of hose than that customary for automobiles. The local fuel company is usually willing to install such a pump.

Oil and water may be supplied from the fuel shed as required. If the field is not near a water main a well may be sunk. Water containing alkali should not be used for radiators.

3. *Hangars.*—The number and size of hangars required to meet any particular rating for airports are listed in the sections on "Rating."

The number and size of hangars depends upon the expected traffic. It is well to start with a single hangar at least 100 x 60 feet. Others may be added as required.

Where the ground is frequently soft or muddy the hangars should be connected with landing strips by a specially prepared surface of cinders, concrete, slag, gravel or other suitable material. Such an area, or "apron," is usually used for blocking up wheels of planes during the "warming up" process.

4. *Marking.*—Roofs of hangars should be properly marked for identification of the airport and for giving such other information as may be necessary. This system of marking is described under "Day Signals and Identification Markings," Section 4. Flood lighting of such identification marks is described under the head of "Night Lighting."

5. *Shops.*—If air traffic warrants, shops should be separate from other buildings. The larger airports will naturally provide for this, but when the initial investment must be held down the shop may be placed within a hangar, usually at the rear. The kind of machinery, tools, miscellaneous equipment, etc., in the shop depends on the number of planes to be serviced. There should be facilities sufficient to permit change of engines and landing gear, as well as minor engine and plane repairs. This does not require any elaborate device. A small derrick or other lifting apparatus may be used. Block and tackle swung from hangar girders is not recommended, as this may strain the cross members excessively.

6. *Field station and rest room.*—The rest room required by the proposed rating system may be in the same building as the field station which serves as an office, weather information station and, in some cases, as a waiting room. The bulletin board or other means for giving pilots the latest weather information should be placed in a conspicuous place. The operations manager or airport manager, should have a clear view of the whole landing area and all buildings. This may necessitate his being stationed in an elevated position, perhaps a small tower having vision in all directions. At the smaller airports no elaborate tower would be necessary. There should be a tele-

phone at the field station. This office is the point at which all visiting pilots will expect to receive information on the weather and other necessary matters connected with flying in that territory. All activities of the field should be centered and controlled at this office.

7. *Sleeping quarters.*—The sleeping quarters mentioned in the rating plan need not conform to any particular standard so long as they afford reasonable comfort, light and heat, and toilet facilities.

8. *Wind indicator.*—A wind indicator is a necessity at all airports and landing fields and is required by the basic regulations. No particular standard is mentioned in the basic requirements, but the type used should give as efficient service as that approved by the Department of Commerce for intermediate fields. (Figure 8.)

Night illumination of the wind indicator and the use of an illuminated wind indicator are discussed under "Night Lighting." This approved type of wind indicator is constructed of fabric equal to Grade A mercerized cotton wing fabric and should be white. It should be properly cut, fitted and strongly stitched. Both ends should be triple lapped and double stitched. Bands at each end should be taped with cotton fabric before fitting and sewing of the wind indicator cone.

Other designs of wind indicators are more elaborated. Any type may be used which will give sufficient aid to pilots in learning the direction of the wind. The illuminated wind "Tee," shown in Figure 26 is also a good day indicator.

9. *Light and power lines.*—If it is not possible to place light and power mains underground, the poles should be removed to a safe distance from the boundaries of the landing area, or placed in the rear of buildings and not higher than the tops of these buildings. In all cases poles, cross trees, transformer boxes, etc., should be painted to give the utmost visibility. A standard system of marking obstructions has been adopted by an interdepartmental committee of the Government. Night lighting of these obstructions is discussed under "Night Lighting."

10. *Fire fighting equipment.*—There is no definite rule for the fire fighting equipment needed, as this will vary with each airport in regard to the type of apparatus used. Fire extinguishers of approved type should be readily available in sufficient numbers at hangars, shops, fueling points and other buildings.

Sand is helpful for extinguishing gasoline or oil fires in hangars or shops. For ordinary fires there should be sufficient outlets on the water mains to protect all structures. Floors of hangars and shops should be kept clear of grease or covered with sand to reduce fire hazard.

11. *Restriction of landing and embarkation areas.*—No one but personnel directly connected with the operation of the airport should be allowed on the landing field proper. The entire area should be fenced. If funds permit, close spaced wire fencing, or similar

barriers, should be used. Protection from propellers in embarking and disembarking areas may be obtained by erecting special enclosures into which the nose of the plane may be taxied, thus cutting off the propeller swept area from the passengers. Another method provides for barring off the danger area by swinging a long gate against the wheels of the plane as indicated in Figure 9.

This illustration also emphasizes the necessity for having all possible servicing done at some point other than the embarkation area. Planes arriving at or departing from airports should stop at the embarkation areas only for taking on and discharging of passengers, mail, and cargo. Adjustments of valves, changing of spark plugs and other necessary minor operations should be done at some other point, as the inexperienced and uninstructed passenger may construe these adjustments as indicative of weakness in the plane or its engines. No opportunity should be given for the public to increase its already erroneous impression of danger in flying.

12. *Protection of unhouseed planes.*—When hangars are not available there must be some reliable method of securing airplanes to prevent damage by storm. One system is to stretch a tarpaulin over the entire plane, pegging it to the ground on all sides. Another plan is to run lines from the wing tips and the tail to stakes prepared for that purpose. Additional lines may be run to landing gear and struts if a violent storm is expected. Sand bags should be available for weighting down planes in emergencies.

13. *First-aid station.*—The proposed rating system requires first-aid stations at certain airports. All airports or landing fields should have this equipment when possible. It should include the usual first-aid supplies and remedies, and should be readily accessible.

14. *Weather instruments.*—The weather instruments mentioned in the proposed rating regulations include the following:

(a) Anemometer.

(b) Barometer.

(c) Thermometer.

(d) Bulletin board, or other efficient method of giving pilots necessary weather information.

15. *Ground day signals.*—Ground day signals mentioned in the proposed rating regulations are described in the following section, "Signals and Identification Markings."

16. *Register.*—The register mentioned in the proposed rating regulations should include the following information.

(1) Number and model of arriving or departing plane.

(2) Owner of plane.

(3) Pilot of plane and his license number.

- (4) Time of arrival and departure.
- (5) Crew and passengers carried.
- (6) Space for remarks covering any unusual situation.

17. *Remote control radio.*—When a radio station is operated from the airport it is desirable to have the towers and antennae removed to a safe distance and operated by remote control. The menace of these obstacles is thus eliminated. They should, of course, be painted to provide utmost visibility.

Day Signals and Identification Markings

1. *Marking of fields.*—Each field, according to the proposed rating system, will have a 100-foot circular marker, as in Figure 10, with a 4-foot band. The name of the field or city should be near the circle. This marker should be placed in the center of fields which are clear for landing in all directions.

The easiest way to construct this marker and the name is to spade up the ground for the circle and the letters, removing the earth to a depth of about six inches. The resulting holes can then be filled with smooth stones to the level of the field so that planes may pass over them without difficulty. Whitewashing the stones will make a good marker visible from several thousand feet, depending, of course, upon the dimensions of the letters. The minimum height for a letter should be 15 feet. If stones cannot be obtained, concrete may be used.

2. *Local guides for pilots.*—It is important to have the roofs of factories, storehouses, or other large buildings in the nearest city marked as indicated in Figure 11, so that any pilot reaching a city may find the airport without a prolonged search for it. The arrow and figures indicate directions and distance to the airport. Airport authorities should have neighboring villages identified by roof markings so that pilots may be able to check their courses.

3. *Marking of runways or landing strips.*—Where the entire field is not available for landing, the landing strips or runways should be identified and indicated by arms projecting from the circle. The positions of the circles and arms for various shapes of fields are shown in Figures 12, 13, 14 and 15. In Figure 16 are shown the dimensions of the arms for marking a standard four-way field with runways or landing strips.

4. *Hangar roof markings.*—Roofs of hangars or other structures on the airport having appropriate areas should be marked as indicated in Figure 17. The symbols and letters should be made in yellow against a dull black background. The arrow with a letter "N" superimposed should point true north and not to magnetic north. Local surveyors can furnish this direction without difficulty. The letters of the name should be made large enough to afford easy visibility from at least three thousand feet. Although it is not

necessary to have the arrows pointing to other cities they may be added when there is sufficient space.

5. *Ground signals.*—A system of ground signals for communication between ground personnel and aircraft is necessary where there is any amount of traffic. Such a system is required at the higher rated airports in the tentative rating system.

The signals should be easily seen from a fair altitude, and should give necessary information as to whether conditions, orders for landing, etc. If the same signals can be used for both day and night this will simplify their use. * * *

6. *Unsafe areas.*—Areas temporarily unsafe for landing on airports supposed to be clear in all directions, or areas not available for any cause, should be plainly indicated. Red flags of a size large enough to draw attention readily should be placed to show the boundaries of the danger area.

If the field is part of an extremely large area and the landing area proper is not fenced separately from the remainder, space available for landing and taking-off should be indicated in some way, either by red flag markers near the boundaries, or by some other system easily discernible from the air. Night lighting of restricted areas is discussed under "Night Lighting."

7. *Necessary obstructions.*—If telephone and power poles, radio masts and other obstructions cannot be removed from the field, they should be painted with alternate chrome yellow and black horizontal bands, the width of each band being one-fifth the height of the structure. The band at the top should always be yellow. For structures higher than 250 feet the bands should be 50 feet wide. Cross trees on poles should also be marked. (Full details in Department of Commerce Information Bulletin No. 13 on "Marking Obstructions in Air Navigation.")

Night Lighting System

1. *List of equipment.*—The equipment for airports completely lighted for use at night includes the following:

- (a) Airport beacon.
- (b) Illuminated wind direction indicator.
- (c) Boundary lights.
- (d) Flood lights.
- (e) Signal lights.
- (f) Ceiling projector.
- (g) Hangar flood lights.
- (h) Auxiliary lights.

2. *Airport beacon.*—The purpose of the airport beacon is to indicate the location of the landing field. It should be installed at such a point as least to

obstruct the landing area. It should be mounted on a structural steel tower with a suitable platform for tending the light (Figure 24) or installed on a tower with a platform surmounting the hangar buildings, the light being at such a height as to project the beam above all surrounding obstructions. The requirement for a beacon light is adequate candlepower, and a distinct characteristic. The standard twenty-four inch rotating beacon has been used with satisfactory results for marking airports. This beacon is fitted with a parabolic mirror and a 1000 watt, T-20, airway incandescent lamp showing a light of over 2,000,000 candlepower. A recommended addition is a lamp exchanger which automatically switches a new lamp into focus in case of lamp failure.

This standard beacon consists of a searchlight drum mounted in a yoke on a base containing a motor and operating gears driving the beacon around the horizon at six revolutions per minute. The construction is such that the mechanism requires oiling at infrequent intervals. The beacon is normally elevated at an angle equal to half of the beam spread, so as to project the greatest quantity of light into the sector used by aircraft.

Other types of beacon lights meeting these requirements may be used. Commercial current should be used whenever practicable, but pole lines extending commercial current to landing fields should not be installed so as to constitute obstructions. When commercial current is not available, an engine driven generating plant may be installed.

3. *Ceiling projector.*—A "ceiling" projector (a narrow beam of light elevated at an angle of 45 degrees) is used to determine the height of clouds, fog, or mist at an airport. The height is determined by pacing the distance from the projector to a point directly under the light spot appearing on the clouds or fog. This distance, "x" is equal to the ceiling height. The apparatus used is a narrow beam incandescent projector approximately 12, 18 or 24 inches in diameter, with a parabolic mirror and a 100-watt concentrated filament lamp. The ceiling projector should be fitted with stray light shields so as to concentrate the beam. The use of this apparatus is shown in Figure 25.

4. *Illustrated wind indicator.* — The illuminated wind indicator shown in Figure 26 is 16 feet long and has side wings extending 5 feet. The apparatus is supported at the cross beam on a metal pipe. It is free to move in any horizontal direction and will operate by means of a vertical fin on a wind velocity as low as five miles per hour. The top surface of the "Tee" is painted with orange and black stripes, to make it extremely visible by day. For night use the top surface is equipped with 10-watt, S-14 bulb, 110- and 120-volt Mazda sign lamps enclosed in green glass hoods. The electric outlets are 18 inches apart and are fitted with 90° elbows which hold the lamps in a horizontal position.

A weight is placed at the forward part of the apparatus to balance the projecting tail. Lighting of the

wind "Tee" may be either by a storage battery enclosed in the "Tee," or preferably be means of a collector ring at the center which transfers current from a field generator or a commercial line.

Another device is the wind cone (Figure 8) mounted in a suitable location on top of the hangar or on a side bracket attached to the beacon tower (Figure 24). The wind cone ordinarily used is from 18 to 30 inches in diameter at the throat, from 8 to 12 inches at the tail and from 8 to 16 feet long. It is constructed of No. 1 mercerized cotton wing fabric treated with a chrome yellow dye so as to increase the visibility of the wind cone. The wind cone is mounted so as to fly with the wind, suitable brass or galvanized fittings being used to permit the rotation of the wind cone.

The wind cone may be internally or externally lighted. The internally lighted wind cone has a lamp mounted at the throat with a suitable reflector throwing the light into the cone. The wind cone will revolve and indicate the direction of the wind. A slip ring assembly is used for carrying the current to the lamp. A lamp of not less than 200 watts in the reflector is required. When the cone is externally lighted, a number of reflectors are mounted on the standard above the wind cone, the light being projected downward, thus flood lighting the cone. This is usually not so satisfactory as the first method.

Another type of wind indicating device utilizes fixed and flashing green lights mounted on a suitable vane showing the direction of the wind. In the case of the flashing light the speed of the wind is shown by a device which revolves at a rate of speed commensurate with the wind velocity and eclipses the light.

5. *Boundary lights.*—White boundary lights (Figure 27) show the outline of the landing field. They should be spaced not more than 250 feet apart, and closer on smaller fields. The circuit for the boundary lights may be series or multiple type. When flood light units are installed in the boundary circuit, the series circuit with a constant current transformer is probably the more economical. In series lighting a safety coil should be installed at the base of the boundary light standards so as to prevent contact with high tension current in the event of a collision, or else each light in the series circuit should be mounted in a series film cutout Mogul socket. The lamps used in connection with series lighting should be 600 lumen, S-24½, 6.6-ampere street lighting lamps. The standard boundary globes should be of opal glass, if clear lamps are used, to prevent glare. In series light the circuit is carried around the field, using 2500 volt No. 8 B and S parkway cable. High tension current up to 2300 volts is used in the series circuits.

When the multiple circuit is used, the electric lamps of the boundary lights should not be less than 25-watt in size and the inside frosted type mounted in boundary fittings, having clear glass globes. The Halophane units for boundary lighting are satisfactory. At the

extremity of landing strips green lights should be installed, giving the range of the landing direction and showing, the best approaches to the landing field. On the sites having obstructions, preventing an approach from that direction, red lights should be installed in the boundary lighting system. Larger wattage lamps should be used, in connection with colored lights, so as to show the same brightness as the boundary lights. Pilots unfamiliar with the landing field will thus be given necessary information in regard to the best landing conditions.

6. *Flood lights*.—Airports should be flood lighted for night landing. Ground surface conditions determine what method of flood lighting is most desirable. The equipment and installation should meet the following requirements:

- (a) Elimination of glare and blinding of the pilot.
- (b) Properly directed light from the correct height.
- (c) Adequate light uniformly distributed.
- (d) Elimination of shadows.

Light projected on a field grazes the surface, and particles, such as pebbles, blades of grass, etc., facing the light are illuminated to a greater extent than horizontal surfaces. Flood lights are therefore elevated slightly but not to an extent that will create a glare or blind the pilot. The ground color will vary, causing a different degree of illumination depending upon the color, and this fact should be considered in determining the lighting requirements. The amount of illumination required for night landing should approximate one-quarter foot candlepower. The lights should be fitted with louvers to prevent the upward diversion of light. A sharp cut-off is essential.

There are several types of flood lighting equipment available. One type is a large dioptric Fresnel lens with a high intensity arc or a 5 or 10 kw. incandescent lamp. (Explanation of symbols in Figure 28.) The distribution of light is shown on figure No. 29. The equipment is installed in such a manner that no stray light is inclined upward to blind the pilot. The lens is elevated from 5 to 15 feet above the ground and the light projected through the Fresnel lens through a horizontal angle of 180 degrees, illuminating the entire field. A narrow screen is sometimes installed to provide a dark sector in the direction of aircraft about to land, and this screen is adjusted to meet varying conditions. Similar apparatus is sometimes mounted on a chassis and moved to any desired location.

Another type of landing field flood lighting equipment is the 24-inch parabolic reflector unit with 40 degree spreadlight lens installed (Figure 30). The light source is a 1500 watt concentrated filament incandescent lamp. The flood lights are grouped along the sides of the field as shown, the landing of the aircraft taking place in a direction at right angles to the projected light. When economy is a necessity the lights in two of the four sides may be eliminated, the lights being grouped according to the prevailing winds.

When landing becomes necessary in a direction at right angles to the prevailing wind the lights along one side are extinguished so that the aircraft will not land into the light.

Figure 31 shows the arrangement of similar apparatus with 80 degrees spread-light lenses.

Figure 32 shows a small dioptric flood lighting equipment with 1000 watt incandescent lamps. This equipment should preferably be equipped with adjustable shields so as to cut off the light in the direction towards the landing plane, thereby preventing blinding of the pilot. The lights are sometimes staggered instead of being placed abreast as shown.

Figure 33 shows the 18" or 24" parabolic flood light unit with 80 degree spreadlight lens, using the high intensity arc or 10 kw. incandescent lamp. Louvers are installed to prevent stray light from being inclined upwards.

The installation of landing field flood lights should be made in accordance with the recommendations of the equipment manufacturer.

7. *Signal lights*.—For communication between airports and airplanes there should be installed an efficient means of signalling, with standard set of signals giving necessary information in regard to weather, landing conditions, etc. A suggested system is to have a panel containing a number of electric lights wired so that different units may be switched on so as to show distinct symbols. The panel should be placed in conspicuous position on the roof of a hangar or other suitable location.

8. *Hangar flood lights*.—The exterior of each hangar should be flooded with a system of lights to assist the pilot to judge his elevation above the field when landing at night. The sides of the buildings, as well as the roofs, should be flood lighted. The usual flood lighting equipment is a system of industrial reflectors with 200 or 300 watt lamps, a number of flood light projectors, or a combination of both. The industrial reflectors are made of various shapes to direct the light in the most advantageous manner to illuminate the surfaces required. They are usually mounted about 10 feet above the roofs of the hangars and buildings which should be earmarked to show the name of the airport which is flood lighted at night. Hangar sides should be painted white so as to reflect the lights from the flood lighting equipment.

9. *Auxiliary lights*.—All obstructions on or near the airport, such as poles, wind mills, buildings, etc., should be surmounted by red obstruction lights in fittings similar to the light standards, as shown in Figures 34 and 35. Major obstructions such as radio masts, should be marked by flashing red lights 60 to 100 flashers per minute.

10. *Cost of equipment*.—The estimated cost of airport lighting equipment for an average field is as follows:

<i>Description</i>	<i>Approximate Cost, Each</i>	<i>Total</i>
50 foot standard airway tower, 1 required	\$100 up	\$100 up
24" revolving search light beacon with 1,000 watt lamps and lamp exchanger, 1 re- quired	650	650
Illuminated wind cone, 1 re- quired	75 up	75 up
Boundary light standards, 60 required	12	720 up
<i>Flood lights:</i>		
Type (a) Large dioptric unit with carbon arc.....	6500	6500
Type (b) Large dioptric unit with 10 kw. incan- descent lamp	5800	5800
Type (c) 12-24" parabolic 45 degrees flood light units	125	1500
Type (d) 24-24" parabolic 45 degree flood light units	125	3000
Type (e) 24 small dioptric flood light units at.....	175	4200
Type (f) 2-18" parabolic flood lights with high in- tensity arc lights.....	1050	2100
Average cost of flood lighting		\$3850
<i>Signal lights:</i>		
Illuminated panel, 1 required	100 up	100 up

<i>Description</i>	<i>Cost, Each Approximate</i>	<i>Total</i>
<i>Ceiling projector:</i>		
Item (a) 12" diam., 1 re- quired	100	100
Item (b) 18" diam., 1 re- quired	210	210
Item (c) 24" diam., 1 re- quired	250	250
Average cost of ceiling projectors		\$185
<i>Hangar flood lights:</i>		
Industrial reflector lights, 40 required	8	320
Flood light projectors, 16 in., 10 required	35	350
<i>Auxiliary lights:</i>		
Obstruction lights, 20 re- quired	15	300
<i>Electrical equipment:</i>		
Transformer constant current type, one required.....	400 up	400 up
Parkway cable, 10,000 feet....	120 per M	1200 up
Weather proof wire, 2,000 feet	30 per M	60 up
<i>Miscellaneous items:</i>		
Switches, conduit insulators, fuses, etc	190 up	190 up
Labor and installation.....		1500 up
Average cost of airport lighting		\$10,000 up

SEAPLANE PORTS AND ANCHORAGES

1. *General consideration.*—The selection and equipment of a seaplane port is treated separately from landing fields, although the general requirements are similar. Basic requirements for seaplane ports are outlined under the section "Seaplane Port Rating," in Part II.

The port should be located on or directly connected with a body of water calm enough for operations in all but violent weather. The area should be sufficiently large and deep to permit landing and taking-off of seaplanes and flying boats without hazard. If the point at which the hangars are located is adjacent to a small body of water only suitable for taxiing to the larger body, the connecting stream or canal should not be so long as to require excessive taxiing, with consequent overheating of engines.

The general rules as to obstacles, prevailing wind, proximity to city, transportation and communication, light, power and water mains, and clear approaches previously outlined for land airports apply equally to

seaplane ports. In addition to obstacles in landing and taking-off, the matter of obstructions in or under the water should be carefully considered. The minimum satisfactory depth for operation of flying boats is 6 feet. Rise and fall of tide at coastal ports should be considered in this connection.

2. *Building and equipment.*—The land field section describing wind indicator, fuel supply, fire hazards and fire equipment, first-aid equipment, sleeping quarters, weather instruments, ground day signals and operations register applies in general to seaplane ports.

The buildings should be arranged most conveniently for operation. Hangars should be separated from the water by space sufficient for running out planes to eliminate direct descent into the water. Usually this space in front of the hangars is constructed of concrete and is used for testing and warming-up engines, loading passengers, cargoes, etc.

Runways from this space into the water may be concrete or wooden ramps, or they may be of the

marine railway type, in which cars are used for lowering the planes into the water. A steep gradient for the runways should be avoided, as this will require more power in hauling out the planes.

Some type of apparatus, such as cradles, dollies or trucks, especially built so that the bottom of planes or flying boats will fit without injury to the craft, must be used on the runways. In most cases a different type of cradle is necessary for each model of plane. Power for hauling out planes must be available. In most cases this is a small tractor, although automobile trucks may be used. Light pontoon type planes may be hauled out by hand.

3. *Mooring buoys.*—At the larger seaplane ports mooring buoys should be installed so that flying boats may be safely anchored over night, thus avoiding necessity for frequent hauling out. However, regard must be had for river or harbor navigation rules so that these buoys will not constitute an obstruction in a regularly used channels.

4. *Power boat.*—Some type of power boat is a necessity at every seaplane port. This should be of reliable type and capable of acting as a tender, rescue boat, or

for towing disabled planes. The speed of this boat is mentioned in the rating regulations.

5. *Day signals and identification markings.*—The suggested method of day signals has already been explained. This applies fully to seaplane ports. Hangar roofs and other buildings should be marked so as to identify the station or nearest city properly. Any necessary obstructions in the water near the landing area should be marked so as to be plainly visible to pilots who are alighting.

6. *Night lighting, signals and identification markings.*—No definite rules can be given for the lighting of a seaplane port, as this is a matter which will have to be taken up in most cases with Federal authorities in order to conform with the regulations on navigational lights. Each problem should be submitted with a complete description of the conditions and a sketch of the intended seaplane port to the Department of Commerce. In general, however, systems of flood lights for the landing area and for wind cone and hangar roof markings, similar to those described for night lighting of land fields, will be used for seaplane ports. Markings and night signals should conform to the suggestions for land airports.

SMALL TYPE FIELDS

Frequently, the smaller municipalities request information from this Department as to the best manner for using fields which do not come up to the general standard of size. In recognition of this commendable interest in aeronautics, and in accordance with the Air Commerce Act for promoting aeronautics, the Department wishes to give all possible assistance to these communities, which may later be able to develop their sites into that grade required for regular airports.

1. *Selection of site and layout.*—Selection and layout of the field should follow the general ideas specified under those headings for larger airports. The maximum landing area should be secured for the longest possible landing strips, both of course in accordance with the clearest approaches. Even though no regular operator may use the airport, its existence will be appreciated by every pilot who flies over or near that part of the country, if it offers a safe landing place. Also, if conditions do not absolutely restrict expansion, the small field may in time be developed into larger airport capable of regular use by mail and other operators.

2. *Equipment.*—The cost of equipment is a large factor in some cities and towns. Only the necessary equipment need be purchased in such cases. This should include:

(a) Facilities for supplying gas, oil and water of the field.

(b) A small building combining office, waiting room and rest-room facilities.

(c) A telephone to the city.

(d) A wind cone or other wind indicator.

(e) A register for arriving and departing aircraft.

A hangar, shop or other equipment may be added later as needed. If it is desired to equip the field for night landing at limited cost, boundary lights, a beacon and an illuminated wind indicator or wind cone may be used.

3. *Marking.*—The field should be marked with the standard 100-foot circles shown in Figure 10, and also with the name of the city or field near the circle. The office roof or rest-room roof should also be marked. Additional identifications should also be placed on buildings in the city or town pointing the way to the field, such as suggested by Figure 11. These matters are of great assistance to pilots and do not require any great outlay of funds.

4. *Attendant at field.*—If conditions warrant, at least one man should be stationed at the field, otherwise there should be some provision made for an attendant being immediately available when a plane lands or circles for landing.

The field conforming to these suggestions will not cause any great financial drain upon the municipality and will, in most cases, be capable of improvement as desired. However, the Department does not mean to imply by the foregoing statements that it will approve the use of any such field which may be selected when hazardous approaches or poor condition of the field may make operations dangerous. Such fields, of course, fail to meet the basic requirement for rating.

COST ANALYSIS

Analysis of airport cost is at present only a general estimate because of the small amount of data available and the diverging standards of construction and equipment. Land values vary in different parts of the country and according to the proximity to the cities. The unit cost per acre is therefore only a rough approximation. When mere airports submit the de-

tails of their construction costs, it will be possible to give a more complete answer to questions of this kind.

1. *Tabulation of various airports.*—In the following table are shown data on several airports in the United States:

AIRPORT CONSTRUCTION

City and Name of Airport	Acres	Land Value	Cost of Improvements	Maintenance	How Acquired	Hangars	Shops	Other Buildings	Length of Runways
Phoenix.....	160	\$36,000	\$3,600	\$600	City-general Funds	0	0	1	2320, 1300
Chicago.....		1,735,000	115,500 Not complete		City Funds	5	0	0	Eight-way Field. (Details in section following.)
Tucson.....	(a) 80	8,000	6,800	625	City-general Funds	1	0	1	2000, 1800
Los Angeles..	80	100,000	10,000	2,500	City land	2	Yes	Yes	3500, 1000
Hartford.....	107	80,250	70,000	11,500	City Funds	5	Yes	Yes	3400, 1500
Atlanta.....	300	Not given	25,000		Leased by city	0	0	1	2500 (two)
Portland.....	193				Privately owned	1	1	0	2600, 2800, 3200
Boston.....	40	1,000,000	76,000		State owned	6	2	2	1500 (two)
Battle Creek..	150	40,000		Leased by C. of C. at \$500 per year	Leased by Chamber of Commerce	2	1	0	2200, 2400
St. Joseph....	141	63,140	40,400	3,000	General City Funds	1	1	1	Four-way field
Philadelphia..	125	125,000	15,000		City ground and				
Pittsburgh....	40	36,000	113,000		Condemnation City and	4	0	1	3800, 1800
Cincinnati....	207	31,050	25,000		County funds	2	0	1	
Cleveland....	700	1,250,000		20,000	Donated	2	1	2	4200, 2200
Muskogee....	60	30,000	19,500		Bond issue	8	3	0	2400
Fort Worth....	175	131,250		Lease with option to purchase by city \$1,250 per year	Leased with option	1	0	4	2800 (two)
Pasco.....	160	4,958	2,560		Leased by County	1	2	0	1700, 1000
Buffalo.....	520	411,000	205,000		Bond issue	3	1	1	3000 (two), 1500 (one)

(a) To be increased to 1280 acres by lease.

Phoenix.—Under direct municipal management. The maintenance is borne by the city. The field is located seven miles from the City Hall. Half of the 160-acre field, at present under cultivation, may be utilized when the traffic warrants.

Tucson.—The city leases the facilities of the port to the Army Air Corps at one dollar per year. Eighty per cent of the maintenance is borne by the city, the remainder by the Army. This field is situated two and one-half miles from the center of town. The city is about to establish a larger field, total acreage 1,280, on land to be leased from the Department of Interior.

Los Angeles.—The Los Angeles Airport, located on the southwestern edge of town, is situated on land controlled by the City Park Board, and is maintained by that body. Hangars were supplied by the Army Air Corps. Other equipment was put in order by the California National Guard, which also assists in maintenance. Los Angeles is now planning a new large municipal airport.

Hartford.—Ninety-six acres of the Hartford Municipal Airport site were obtained by the conversion of city property, and nine acres by purchase. The city has an option on another plot of 434 acres and is negotiating for 16 more. The airport, two miles south of the State Capitol, is under direct city management, and all maintenance cost is borne jointly by the city and the state.

Atlanta.—Eight miles from town the city of Atlanta has acquired 300 acres from a private estate, under a five-year lease with option to purchase at one-half the real value, which option will probably be exercised. Lighting is now completed.

Chicago, Ill.—Chicago has expended \$175,000 on runways, drainage and first lighting installations. The runway system covered to date is as follows:

East and West, 2900 feet by 100 feet; north and south, 2200 by 100 feet; northeast by southwest, 3200 by 150 feet; northwest by southeast, 1800 by 150 feet. The western portion of the field is to be prepared for use in the immediate future and will involve an outlay of a sum nearly equal to that used on the finished eastern section. Hangars and shops are provided and the field is equipped for night flying. It is situated at 63rd and Cicero Ave.

Boston.—This state and municipal airplane and seaplane airport is situated close to the center of Boston on land and water owned by the state. Portions are rented to the Army and Navy. It is also used by the National Guard, Reserves and by private enterprise. The State Legislature authorized the establishment and leasing to the Government and appropriated \$43,000. The Boston Chamber of Commerce, through public subscriptions, the City of Boston, the Federal Government and the National Guard added \$33,000 to the investment. In addition, the Federal Government erected hangars for its own

purposes. The value of the filled-in land is estimated at \$1,000,000.

Portland, Me.—The new Portland Airport was recently built by commercial interests on land situated 5½ miles south of Portland. It is planned to turn the operation of this airport over to the municipality for operation. This airport, now nearing completion, will be equipped with full night flying facilities, hangars and repair shops. Runs of 2600, 2800 and 3200 feet will be provided. The field is now available for landing, but all facilities will not be in operation before early spring.

Battle Creek.—Three miles from the center of the city is situated the Battle Creek Airport on land leased until 1929 with option of purchase. A committee appointed by the Chamber of Commerce is now devising a plan for purchase of the property. Maintenance cost is borne by local interests and civic organizations.

St. Joseph, Mo.—The Rosecrans Municipal, located on land purchased by the city from general funds, is two and one-half miles northwest of St. Joseph. The maintenance cost is borne by the city. Present source of revenue amounts to \$3,000 per year derived from the renting of hangar space.

Buffalo.—The Buffalo Airport is directly managed by the Air Division, Department of Parks and Public Buildings. Revenue is derived from the leasing of hangar space and facilities to manufacturers and operators. It is situated two miles east of the city line. Distance from Post Office, eight miles. Railroad connection with Lehigh Valley R. R.

Philadelphia.—The Philadelphia municipal field is managed by a board of control, representing the city, State of Pennsylvania, National Guard and the concessionaires. It is located on the bank of the Delaware River five miles southwest of the City Hall. Complete lighting system has been installed.

Cincinnati.—The land for the Lunken Airport, five miles southeast of Cincinnati, was deeded by Mr. E. H. Lunken to a Cincinnati corporation. This corporation leases part of the field for Army use at one dollar per year. Money raised by the sale of stock locally was put into improvements on the field.

Cleveland.—Cleveland Airport is located on land purchased by bond issue and maintained by the city. The airport is located eight miles from the center of town and is equipped for night flying.

Muskogee.—Forty of the sixty acres are leased and twenty are used by special agreement between the city and the lessors. The Army leases from the city and maintains the field. It is located two miles south of the city.

Pittsburgh.—Rodgers Field, Pittsburgh's Municipal Airport, is rented by the Army Air Corps for training purposes for one dollar per year. Maintenance is borne by the city and county. Rodgers Field is situated eight miles northeast of Pittsburgh.

Fort Worth.—Municipal Airport, seven miles due south of Fort Worth, is situated on land leased for four years with an option to purchase. Maintenance is by the city. Night flying equipment is provided.

Pasco.—The Pasco Airport is leased by Franklin County, which rents the use of the field and hangar to private operators. It is located one mile north of the City Post Office.

As these airports are located in widely separated parts of the country, it is possible that each case will serve as a basis for calculation for some cities similarly situated. Further information in regard to any particular city mentioned can be obtained by addressing the manager of the Airport in question, or by addressing the Chamber of Commerce at the specific city concerned. The Department of Commerce publishes bulletins describing all airports as completed.

Establishment of airports at other cities.—The foregoing list is not by any means comprehensive. It represents only a small number of the airports in the country. The Department will be very glad to receive similar information in regard to any airport or landing field.

Many cities are contemplating or are already undertaking the construction of airports or extensive additions to present fields. The number of airports (Army, Navy, municipal, commercial) Department of Commerce Intermediate and other marked auxiliary fields now totals 1,016. In addition there are proposed 306 more airports and 51 are under construction, making a total of 1,373. Of the total 574 are municipal fields either in operation or proposed, and 207 commercial. It is estimated the total number of improved fields of all types will run to 1,600 by June 30, 1928.

MARKING OBSTRUCTIONS IN AIR NAVIGATION

Following is the method of marking air navigation obstructions, as approved by the Departments of the Army, Commerce and Navy:

Skeleton Towers

1. Obstruction towers, such as radio masts, transmission towers, flag poles, etc., in the immediate vicinity of an airport, intermediate landing field or civil airway, be painted so as to increase the visibility. Three methods of painting are recommended:

(a) For the maximum desired visibility, towers less than 250 feet in height shall be painted alternate bands of white and chrome yellow separated by black bands one-half the width of the white and chrome yellow bands. The white and chrome yellow bands shall be one-seventh of the height of the obstruction, and the black bands shall be one-fourteenth of the height of the obstruction, terminating with a white band at the top. For towers over 250 feet in height, the width of the white and chrome yellow bands shall be thirty-six feet and the width of the black bands eighteen feet.

(b) As an alternative, radio masts, transmission towers, flag poles, etc., to be painted alternate bands of chrome yellow and black, the width of the bands being one-fifth of the height of the structures for all structures less than 250 feet and for structures over 250 feet high the bands to be fifty feet wide, terminating with a chrome yellow band at the top.

(c) As another alternative, that structures, such as radio masts, transmission towers, flag poles, etc., be painted alternate bands of black and white or black and aluminum, the width of the bands being one-fifth the height of the structure for all structures less than 250 feet, and for structures over 250 feet the bands being fifty feet wide, terminating with a white and aluminum band at the top.

2. Obstructions to be marked with flashing red lights exhibited from sunset to sunrise, the obstruction light consisting of 100-watt lamp in a high transmission red water-proof glass globe and flashing 80 to 120 flashes per minute, the light to be mounted on top of the obstruction. The committee recommends that major obstructions in the vicinity of airways and landing fields be marked with similar flashing red lights of higher candlepower to offer adequate protection to aircraft, higher candlepower being obtained by use of higher wattage lamps or by the use of properly designated optical apparatus.

3. For radio towers the use of additional fixed red lights, using fifty-watt lamps, one being placed two-thirds of the height of each tower and one at one-third of the height of each tower. These lights should be arranged so as to be visible from any angle of approach.

Transmission Lines

4. Considering an airway as a lane between airports about three miles in width, at the intersection of transmission line wires and airways the structural towers of transmission lines to be painted as hereinbefore recommended so as to increase the visibility of the transmission towers.

5. Each pole of the transmission line within $1\frac{1}{2}$ miles of the center line of the airway to be marked with red flashing obstruction lights, the frequency of the flashes being from 80 to 120 per minute, and the lamps being not less than 25-watt in high transmission red glass water-proof globes.

Transmission Lines Crossing Navigable Waters

6. Supporting towers of transmission line spans crossing navigable waters designated as a civil or mili-

tary airway, to be painted as hereinbefore recommended for skeleton towers to increase the visibility of the towers.

7. Transmission towers to be marked with a red flashing light visible in all directions from the top of the towers, consisting of a 1,000-watt lamp in a 300 m/m or 375 m/m aeronautic type optic, showing in every direction from the horizon to the zenith, the light to be flashed not less than sixty flashes per minute. Suspension wire to be installed paralleling the transmission wires, the wire to carry three 100-watt white lights evenly spaced for spans 1,000 feet in length or less and that for longer spans an additional light be provided for each 500 additional feet or fraction thereof, the lights being enclosed in water-proof globes suspended from the wire.

8. Consideration should be given to the installation of suitable day markers supported from a suspension wire paralleling the transmission line, the day markers consisting of streamers, cones or panels constructed in such a manner as to facilitate the maintenance of the day markers and painted chrome yellow and white stripes, each band being separated by a black stripe of half the width of the chrome yellow and white stripes. Further study is to be given to the method of installing and maintaining day markers in order that a practicable arrangement may result.

Bridge Spans

9. There is indorsed the recommendation of the Corps of Engineers, U. S. Army, regarding the marking of bridge spans as follows:

"That if the display of lights and signals on any work hereby authorized by the Corps of Engineers, U. S. Army, is not otherwise provided for by law,

such lights and signals as may be prescribed by the Bureau of Lighthouses, Department of Commerce, shall be installed and maintained at the expense of the owner."

Definitions

10. The term civil airway is considered to mean a route in the navigable air space designated by the Secretary of Commerce as a route suitable for interstate or foreign air commerce.

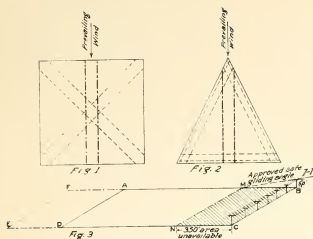
11. A major obstruction is regarded as an obstruction which projects above the surroundings in such a manner and of such nature as to form a serious hazard to flying on an airway or in the vicinity of an airport or intermediate landing field.

12. An ordinary obstruction is regarded as an obstruction in the vicinity of a civil airway, airport or intermediate landing field which may interfere with safe navigation, landing or taking off of aircraft.

13. Standard color charts and specifications for paint will be prepared by the Bureau of Standards in conference with the Air Corps, U. S. Army, and Bureau of Aeronautics, Navy Department, for making available a uniform application of colors that will show maximum visibility under all prevailing weather conditions.

14. Lights, using any other illuminant than electricity may be substituted, provided they have the same lumen output and are equivalent in effect to the lights described.

15. Obstruction lights shall burn continuously from sunset to sunrise, and at all other times when poor visibility requires the use of lights for safe air navigation.



Figures 1 and 2 illustrate alignment of landing strips with the prevailing wind. Fig. 3 illustrates reduction of landing area by obstacles such as telephone poles along the edge of field.

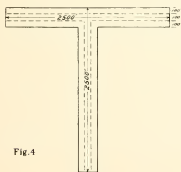


Fig. 4

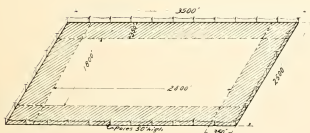


Fig. 5

Fig. 4 indicates the removal of obstacles from the landing area according to the rule for margins and the obstacle formula.

Fig. 5 shows how a very good field may be made dangerous for operation and its area extremely reduced because of obstacles on all four sides.

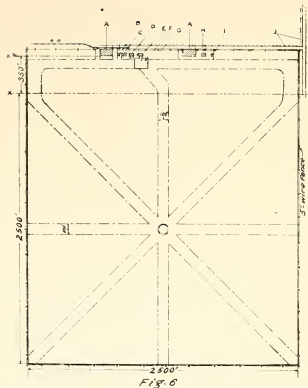


Fig. 6. An illustration of a model airport. The landing area proper is 2,500 ft. square and, if possible, should be available for landing at any spot. If this condition cannot be obtained landing strips or runways may be laid out as indicated in the sketch.

Buildings at the northern end of the field are removed from the landing area by a distance of 350 ft., calculated as seven times the height of the tallest building. Power and telephone wires are underground as indicated by "J".

"A", hangar; "B", fuel shed; "C", underground tanks placed near railroad spur; "D", quarters for personnel; "E", waiting room; "F", fuel pump on edge of loading platform "G"; "H", repair shop; "I", fire fighting apparatus.

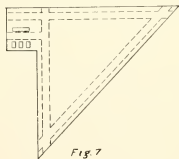


Fig. 7

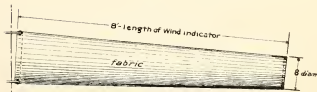


Fig. 8

Fig. 7. A field using a remote section for hangars or other buildings.

Fig. 8. Standard "wind cone."

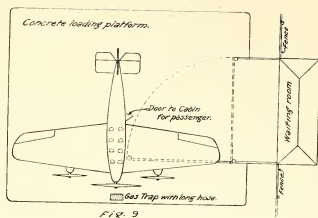


Fig. 9. Loading platform is for convenience of taking on and discharging passengers and cargo. Planes may be fueled from the gas trap at the same time. The gate shown swings against the hub of the left wheel to create a safety area while the propellers are turning.

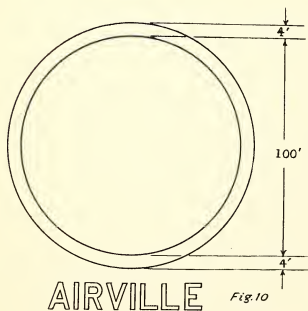


Fig. 10. Standard circular marker and name of airport city.

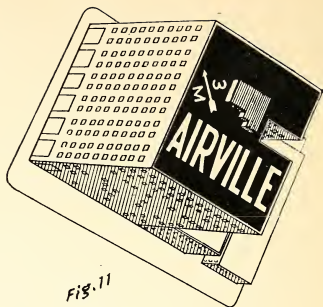


Fig. 11. A guide to the airport.



Fig. 12



Fig. 13



Fig. 14



Fig. 15

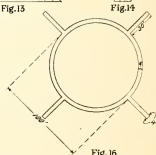


Fig. 16

Figs. 12 to 15 show the method of placing circular markers and projecting arms to indicate direction of landing strips.

Fig. 16 shows the dimensions for a circular marker and arms to indicate a standard four-way field.

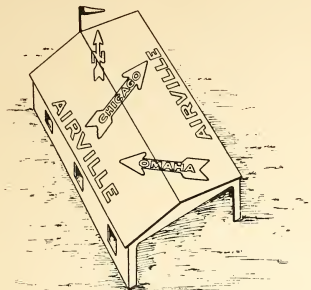


Fig. 17

Fig. 17. Hangar markings and identifications.

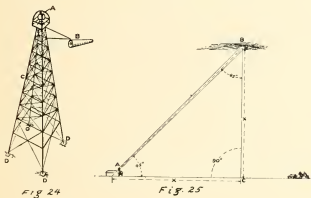


Fig. 24. Standard 50' tower with rotating beacon on platform. The wind cone, suspended from a bracket below the platform, is free to swing in any direction. The base of the tower is concrete.

Fig. 25. Ceiling projectors used for obtaining the height of clouds, fog or mist above the ground.

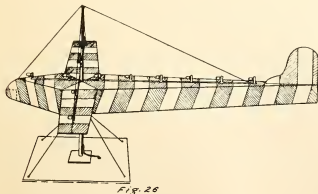


Fig. 26. Illuminated wind indicator.

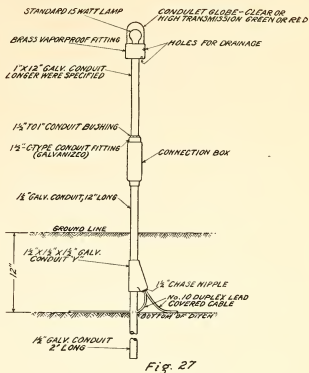


Fig. 27. Standard boundary light and mount.

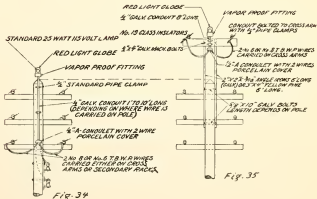
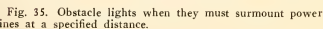


Fig. 34. Mounting of obstacle lights directly on top of poles.



SYMBOLS

FLOOD LIGHT UNITS

-  LARGE DIOPTRIC FRESNEL LENS, WITH HIGH INTENSITY ARC LIGHT OR 5KW-10KW INCANDESCENT LAMP
-  PARABOLIC FLOOD LIGHT UNIT 24-INCH DIAMETER, 40 DEGREE SPREADLIGHT LENS, 1500 WATT INCANDESCENT LAMP
-  PARABOLIC FLOOD LIGHT UNIT 24-INCH DIAMETER, 80 DEGREE SPREADLIGHT LENS, 1000 WATT INCANDESCENT FLOOD LIGHT LAMP
-  SMALL DIOPTRIC LENS WITH 1000 WATT INCANDESCENT FLOOD LIGHT LAMP (LIGHT MAY BE FITTED WITH ADJUSTABLE SHIELDS TO PREVENT BLINDING FLUT)
-  36-INCH PARABOLIC FLOOD LIGHT UNIT, 80 DEGREE SPREADLIGHT LENS, HIGH INTENSITY ARC LIGHT (NORTH LIGHT USED FOR NE-SW LANDINGS AND SOUTH LIGHT USED FOR SE-NW LANDINGS)
-  BEACON TOWER AND 24-INCH REVOLVING SEARCHLIGHT WITH 1000 WATT INCANDESCENT LAMP
-  HANGERS, FLOODLIGHTED AT NIGHT TO SHOW AIR MARKINGS ON ROOFS
-  BOUNDARY LIGHTS (WHITE)
-  RED LIGHTS TO MARK OBSTRUCTIONS
-  GREEN LIGHTS TO MARK BEST APPROACH
-  GROUND MARKER FOR RECTANGULAR FIELD, 100 FT. DIAMETER
-  GROUND MARKER FOR FIELD WITH "T" SHAPED LANDING AREA
-  GROUND MARKER FOR FIELD WITH "L" SHAPED LANDING AREA
-  GROUND MARKER FOR FIELD WITH "X" SHAPED LANDING AREA
-  ELECTRIC POWER OR TRANSMISSION LINE
-  TELEPHONE LINE
-  RAILROAD
-  BUILDINGS
-  WATER OR OIL TANK
-  TREES

Fig. 28

Fig. 28. Symbols used in Figs. 29 to 33.

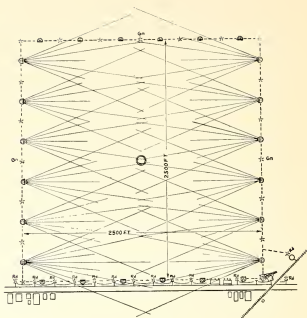


Fig. 30

Fig. 30. Parabolic reflector unit (34") with 40° spread light lens.

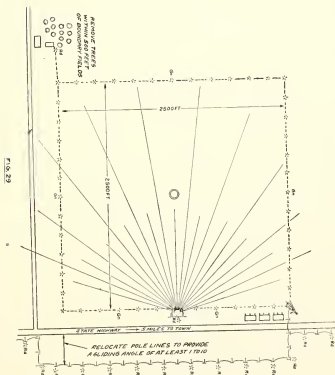


Fig. 29

Fig. 29. Large dioptric unit system for night lighting.

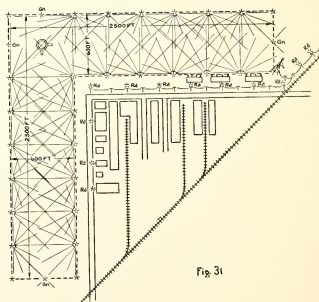


Fig. 31

Fig. 31. Parabolic reflector units with 80° spread light lens.

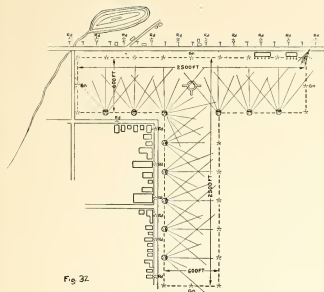


Fig. 32. Small dioptic flood lighting equipment with 100 watt incandescent lamps.

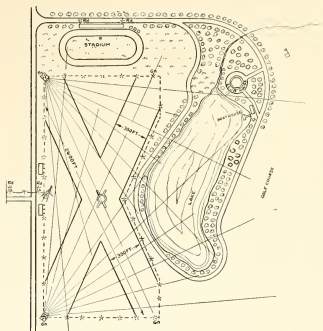


Fig. 33. Parabolic flood light unit (18" or 24") with 80° spread lamps and high intensity are for 10 kw. incandescent lamp.

